

Risk Propensity, Risk Perception, and Sensation Seeking in U.S. Army Soldiers: A Preliminary Study of a Risk Assessment Task Battery

Approved for public release, distribution unlimited.

**U.S. Army
Aeromedical Research
Laboratory**

Notice

Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, Virginia 22060-6218. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about Laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Human Use

Human subjects participated in this study after giving their free and informed voluntary consent. Investigators adhered to Army Regulation 70-25 and USAMRMC Regulation 70-25 on use of volunteers in research.

REPORT DOCUMENTATION PAGE					<i>Form Approved OMB No. 0704-0188</i>	
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.						
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.						
1. REPORT DATE (DD-MM-YYYY) 13-10-2010		2. REPORT TYPE Final			3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Risk Propensity, Risk Perception, and Sensation Seeking in US Army Soldiers: A Preliminary Study of a Risk Assessment Task Battery					5a. CONTRACT NUMBER	
					5b. GRANT NUMBER	
					5c. PROGRAM ELEMENT NUMBER	
					5d. PROJECT NUMBER	
6. AUTHOR(S) Amanda M. Kelley William D.S. Killgore Jeremy R. Athy Michael Dretsches					5e. TASK NUMBER	
					5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Aeromedical Research Laboratory P.O. Box 620577 Fort Rucker, AL 36362-0577					8. PERFORMING ORGANIZATION REPORT NUMBER USAARL 2010-02	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command 504 Scott Street Fort Detrick, MD 21702					10. SPONSOR/MONITOR'S ACRONYM(S) USAMRMC	
					11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited.						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT Preliminary evidence shows that Soldiers' propensity to engage in risky behaviors is significantly correlated with the severity of combat experiences during a recent deployment. This relationship was weak & assessed in Soldiers post-deployment. A battery of tasks measuring risk propensity, risk perception, risk aversion, & sensation seeking was assembled to be used in study tracking individual change in risk taking behaviors. The objective of this preliminary study was to evaluate the effects of repeated exposure to the battery and associations between the tasks. Participants were 181 active duty Soldiers not currently engaged in the deployment cycle; 19 of the participants reported having been deployed previously. Participants completed the task battery including the IGT, BART, EVAR, BSSS, & an exploratory measure of invincibility once per day for 3 consecutive days. Results suggest suitability of the task battery for future use given that participants performed at increasing optimal levels on the behavioral measures, remained stable on the trait assessments, & the trait assessments correlated with performance on the behavioral assessments.						
15. SUBJECT TERMS risk propensity, risky behaviors, decision making						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 44	19a. NAME OF RESPONSIBLE PERSON Loraine Parish St. Onge, PhD	
a. REPORT UNCLAS	b. ABSTRACT UNCLAS	c. THIS PAGE UNCLAS			19b. TELEPHONE NUMBER (Include area code) 334-255-6906	

Reset

Acknowledgements

The authors would like to express their sincere gratitude to the following people for their contributions to this project.

- Ms. Elizabeth Stokes for help with administrative matters.
- Dr. Loraine St. Onge for her editorial assistance.
- Ms. Melinda Vasbinder, Ms. Lana Milam, SGT Robert MacNeill, SGT William Schober, and Mr. Bradley Erickson for their assistance with the data collection.
- LTC Robert Wildzunas for administrative support at the onset of this project.

Table of contents

	<u>Page</u>
Introduction.....	1
Military significance	1
Background.....	2
Combat Exposure Risks.....	3
Research Objectives.....	3
Methods.....	3
General.....	3
Participants.....	3
Procedure	4
Task Battery	4
Modified Iowa Gambling Task (MIGT).....	4
Evaluation of Risks Questionnaire (EVAR)	4
Balloon Analogue Risk Task (BART).....	4
Brief Sensation Seeking Scale (BSSS)	4
Invincibility Scale	5
Results.....	5
Effects of Repeated Exposure.....	5
Modified Iowa Gambling Task (MIGT).....	5
Evaluation of Risks Questionnaire (EVAR)	6
Balloon Analogue Risk Task (BART).....	6
Brief Sensation Seeking Scale (BSSS)	7

Table of contents (continued)

	<u>Page</u>
Invincibility Scale	7
Correlational Analysis	8
Discussion	8
Limitations and future studies.....	8
Conclusions.....	9
References.....	10
Appendix A. Example of a Trial of the Modified Iowa Gambling Task.....	12
Appendix B. Evaluation of Risks Questionnaire	15
Appendix C. Balloon Analogue Risk Task.....	22
Appendix D. Brief Sensation Seeking Scale.....	29
Appendix E. Invincibility Scale.....	30

List of figures

1. Percentage of fatal ground accidents that involved post-deployment personnel	2
2. Modified Iowa Gambling Task performance by Block (10 trials) and Day (1, 2, or 3).....	6
3. Balloon Analogue Risk Task performance by Block (10 trials) and Day (1, 2, or 3)	7

Introduction

Anecdotal evidence indicates that some Soldiers engage in more high risk behaviors post-deployment compared to that prior to deployment. A general definition of risk taking behavior is a behavior guided by sensation or stimulation (i.e., reward) with a high probability of negative or adverse outcomes (Magar, Phillips, & Hosie, 2008). Types of high risk behaviors relevant to this study (particularly public health risks) include risky sexual behaviors, risky driving (including not wearing a seat belt and speeding), drunk driving, increased alcohol and drug use, and heavy smoking. While deployed, Soldiers are under conditions of high physical, psychological, and emotional stress. Killgore, et al. (2008) hypothesized that the effects of prolonged exposure to emotional stressors may impact brain regions (specifically the limbic system) in such a way that Soldiers may have difficulty adjusting to a non-wartime environment upon returning from a deployment. For example, some evidence shows that Soldiers with Post-Traumatic Stress Disorder (PTSD) have diminished activity in the limbic system and regions of the prefrontal cortex (Molina, Isoardi, Prado, & Bentolila, 2007), which might suggest low basal arousal levels. However, increased risk to engage in high risk behaviors may not be limited to Soldiers who are suffering from PTSD or other traumas.

Military significance

Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) have been supported by over one million deployed U.S. Soldiers in recent years. The conditions under which these Soldiers carry out their missions are both physically and psychologically stressful. Previous research shows a relationship between combat experience and mental health problems (e.g. Hoge et al., 2004; Hoge, Auchterlonie, & Milliken, 2006). A recent report published by the RAND Corporation (Tanielian & Jaycox, 2008) documented the psychological wounds of these deployments including PTSD, Major Depression (MD), and Traumatic Brain Injury (TBI). According to this report, an estimated 300,000 Soldiers are currently suffering from either PTSD or MD and 320,000 Soldiers have a probable TBI. These injuries continue to receive a lot of attention from the public, media, and research community.

Another area of public health concern is the anecdotally reported increase in risky behaviors exhibited by Soldiers post-deployment which has received considerably less attention than other veteran issues such as PTSD. These behaviors, in some cases, may be related to mental health problems faced by the returning Soldier (e.g., mental health problems are associated with increased substance use). However, only one study investigated the relationship between risk propensity and deployment outside of mental health problems (Killgore, et al., 2008). Risky decisions increase the likelihood of negative consequences such as injury to self or others for the post-deployed Soldier. In an effort to understand and potentially develop intervention programs to prevent risky behaviors and attitudes in Soldiers post-deployment, the present study evaluated changes in these attitudes and behaviors in Soldiers over the deployment cycle.

One example of high risk behavior is erratic driving. The percentage of post-deployment personnel that are involved in fatal ground accidents increased in the past few years relative to

previous years (figure 1). Similar evidence was reported by Hooper et al. (2006) who showed that, in a nested case-control study, deployment significantly increased Soldiers' risk of a fatal motor vehicle accident (an Odds Ratio of 1.45 was reported). It should be noted that the Hooper et al. study examined accidents occurring between 1991 and 1995 in a cohort of Gulf War era veterans. It has also been shown that Soldiers post-deployment engage in heavy alcohol consumption and smoking (e.g., health survey).

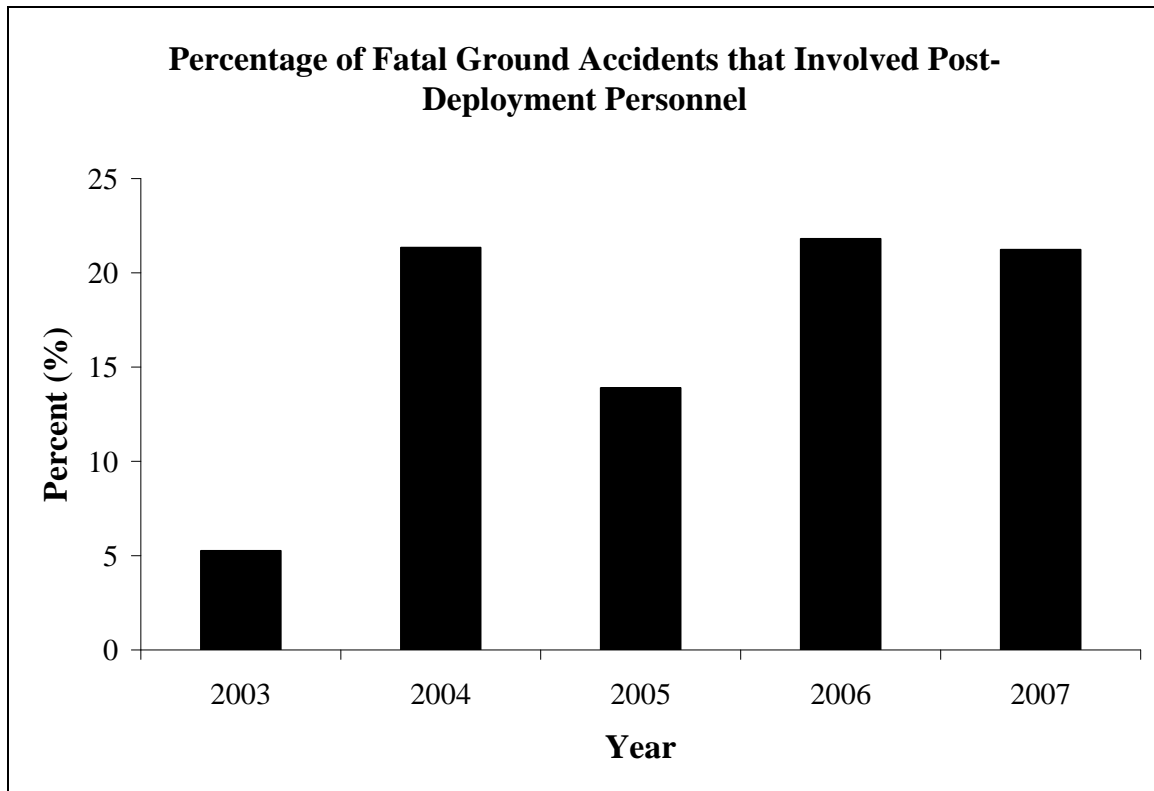


Figure 1. Percentage of fatal ground accidents that involved post-deployment personnel (U.S. Army Combat Readiness/Safety Center, 2008).

Background

Minimal research has investigated the relationship between risk propensity and combat experiences. In the Killgore et al. (2008) study, Soldiers reported their combat experiences immediately upon return from deployment and were again evaluated 3 months later using the evaluation of risks questionnaire (EVAR) and an assessment of emotional and mental health, substance use, and aggressive/violent behaviors. The results suggested that those who experienced more severe and intense combat were at a slightly greater risk to engage in high risk behaviors post-deployment. Even though the strengths of the relationships revealed in this study were weak, the results were highly statistically reliable, thus indicating a potentially strong impact on public health given the large number of veterans in our country. Also, the results show that the combat experiences that were related to an increase in risk propensity for some respondents, were reported by over half of the participants. In other words, violent and intense

combat experiences were common to the respondents. It is unclear then, what other factors may influence one's susceptibility to increased risk propensity following combat exposure.

Combat exposure risks

Research shows that combat exposure is linked to increased risk for mental health problems such as PTSD, MD, and substance abuse (e.g., Hoge et al., 2006; Prigerson, Maciejewski, & Rosenheck, 2002). Consequently, engaging in health risk behaviors is typical behavior of people suffering from PTSD and MD. Likewise, deployed Soldiers are at an increased risk for TBI, particularly mild TBI (mTBI). Research shows that patients with right-sided lesions tend to make riskier decisions and have a lack of concern for negative consequences (Rahman, Sahakian, Cardinal, Rogers, & Robbins, 2001). Gianotti et al. (2009) showed that decreased activity in the right prefrontal cortex indicates lower regulatory abilities and subsequently greater risk-taking behavior. Finally, it has been suggested that some post-deployment risk taking behavior may be attributed to a shift in cognitive appraisal of risks or one's ability to accurately perceive risks in the environment (Bell, Amoroso, Wegman, & Senier, 2001). Specifically, if deployment is retrospectively perceived as very risky or dangerous, then the perceived risk of negative consequences of risky behaviors such as drinking and smoking post-deployment is lower than the actual risk level associated with those activities. Given the lack of longitudinal studies in the literature, it is unclear if this skew in risk perception returns to baseline over time.

Research objectives

This project served as a preliminary study to a longitudinal study of which the goals are to assess the connection between combat exposure/deployment and personality traits, cognitive abilities, risk propensity, attitudes about risk, and actual risk behaviors across the deployment cycle. The objectives of the current study, however, were: to evaluate the effects of repeated exposure to a task battery assessing risk propensity, risk perception, learned reward/punishment contingencies, and sensation seeking using both (1) subjective and (2) objective measures; and (3) to explore the associations between performances on these tasks.

Methods

General

The study protocol was approved by the U.S. Army Aeromedical Research Laboratory's Human Use Committee (HUC). The study employed a within-subjects design to evaluate the suitability of a task battery for future use in longitudinal studies of risky behavior and risk propensity in Soldiers. Participants completed the task battery once per day for three consecutive days.

Participants

Participants were 213 active-duty U.S. Army Soldiers. The mean age was 25 years and 6 months and the mean education level was 15.8 years (e.g., 12 years = high school diploma). Of

the 213 participants, 181 were male, and 22 had combat experience. Volunteers did not receive any compensation for participation.

Procedure

Upon entering the laboratory, participants were briefed on the study's objective and procedures. After written consent was obtained, participants were seated at a computer and completed a series of tasks: Iowa Gambling Task, Balloon Analog Risk Task, Brief Sensation Seeking Scale, Evaluation of Risks Questionnaire, and Invincibility Scale. The tasks were administered using Psychology Software Tools' E-Prime 2.0 experiment generator software package. Participants were dismissed upon completion of the tasks. Participants returned at approximately the same time and repeated the task battery on all three days of the study. All tasks were administered on all three days with the exception of the Invincibility Scale which was only administered on Days 1 and 3.

Task battery

Modified Iowa Gambling Task (MIGT). The ability to adjust behavior to changing reward/punishment contingencies and learn to identify risky choices is an important aspect of sound judgment and has been shown to be impaired in patients with lesions to the ventromedial prefrontal cortex (Bechara, 2001; Bechara et al., 2001; Bechara, Tranel, & Damasio, 2000). A well-researched and validated instrument for measuring this ability is the Iowa Gambling Task (Bechara, Damasio, Damasio, & Lee, 1999; Bechara, Damasio, Tranel, & Damasio, 1997; Bechara, Tranel, Damasio, & Damasio, 1996), which is administered to participants via computer and has multiple alternate versions for repeated testing. Administration time is approximately 20 minutes. The version of this task that was used in the current study was similar to that described in Bechara, Damasio, Damasio, and Lee, 1999. The version used in this study did not use any auditory feedback and the decks were each a different color. Each day, an alternate version of the task was presented, differing only with respect to the spatial location of the card decks (e.g., deck A was "good" on the Day 1 version but "bad" on Days 2 and 3). An example of the task is included in appendix A.

Evaluation of Risks Questionnaire (EVAR). The EVAR is a 24-item questionnaire that has been used effectively to measure individual variability in risk assessment in previous research (appendix B; e. g., Killgore, et al., 2008). Individuals mark a point along a 100 mm bipolar visual analogue scale to indicate their preference for various types of risky activities. There are five sub-scales of the EVAR; *self-control*, *danger seeking*, *energy*, *impulsiveness*, and *invincibility*. Administration time is approximately 5 minutes.

Balloon Analogue Risk Task (BART). This is a computerized task that requires the participant to fill a simulated balloon with air (appendix C; Lejuez et al., 2002). Points are given for maintaining the flow of air and keeping volume of the balloon as full as possible. The more the balloon is expanded, the more points are gained. However, all points are lost if the balloon is over-inflated and pops. Thus, the goal is to earn as many points as possible by keeping the balloon inflated safely. The task provides a measure of the willingness to take risks versus

“playing it safe.” To analyze performance on this task, the most commonly used dependent measure is pump count (number of times the balloon is pumped on a trial). Administration time is approximately 25 minutes.

Brief Sensation Seeking Scale (BSSS). The BSSS is an eight-item scale that was adapted from Zuckerman’s (1994) Sensation Seeking Scale V. This scale assesses the same main components as the SSS-V but eliminates the forced-choice format and replaces it with a likert scale format (appendix D). The BSSS has been shown to perform similarly to the longer scale from which it was adapted (Stephenson, Hoyle, Palmgree, & Slater, 2003). Administration time is approximately 5 minutes.

Invincibility Scale. This 50-item scale was developed to measure risk propensity and one’s perceived susceptibility to consequences (appendix E; Killgore, Kelley, & Balkin, 2009). Administration time is approximately 30 minutes.

Results

Effects of repeated exposure

The effects of repeated exposure on the tasks were evaluated using repeated measures analyses of variance (ANOVAs), multivariate analyses of variances (MANOVAs), and *t*-tests. Participants with incomplete data for each measure were excluded from the analyses. Incomplete data primarily resulted from computer error or test session absence.

Modified Iowa Gambling Task (MIGT)

In this task, participants completed 100 trials. Those trials were divided into 10 blocks (10 trials per block). The dependent variable calculated to analyze performance on the MIGT was the difference between the number of advantageous choices and disadvantageous choices per block. The possible range of this variable was -10 to +10. A 10 (block) x 3 (day) repeated measures ANOVA ($N = 164$) revealed a significant main effect of block, $F(2, 328) = 8.31, p < .001$, significant main effect of day, $F(9, 1476) = 33.39, p < .001$, and a significant interaction, $F(18, 2952) = 3.83, p < .001$. These results indicate that participants were sensitive to the reward/punishment contingencies in that performance improved across test sessions (figure 2).

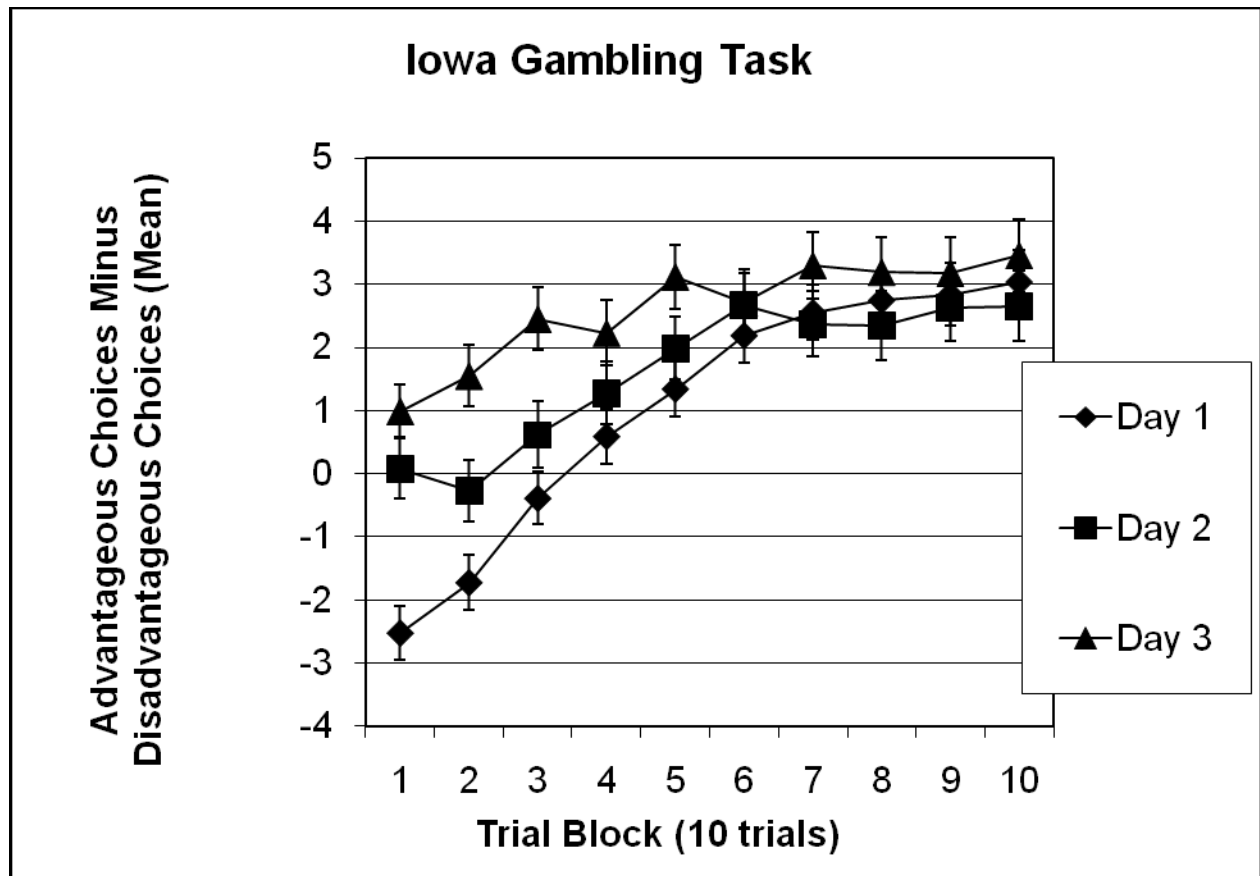


Figure 2. Modified Iowa Gambling Task performance by Block (10 trials) and Day (1, 2, or 3). Error bars are standard error of the means.

Evaluation of Risks Questionnaire (EVAR)

To evaluate the results of the EVAR, the total and five sub-scale (*self-control*, *danger seeking*, *energy*, *impulsiveness*, and *invincibility*) scores were calculated. A repeated measures MANOVA was used to evaluate the effect of Day (1, 2, and 3) on the six scores which showed a significant main effect of day, $F(2, 386) = 3.103$, $p = .046$. Subsequent t -tests were non-significant at the Bonferroni corrected alpha level ($.05/15 = .003$). Nineteen participants were excluded from this analysis for incomplete data ($N = 194$).

Balloon Analogue Risk Task (BART)

In this task, participants completed 30 trials. Those trials were divided into 3 blocks (10 trials per block). Mean pump count (number of times a participant pumped a balloon on a trial) was calculated for each participant. Trials on which the balloon popped were discarded from the analysis. A 3 (block) x 3 (day) repeated measures ANOVA ($N = 191$) revealed a significant main effect of block, $F(2, 380) = 11.01$, $p < .001$, significant main effect of day, $F(2, 380) = 7.71$, $p = .001$, and a significant interaction, $F(4, 760) = 9.07$, $p < .001$. These results showed that participants became more risk-seeking across test sessions (figure 3).

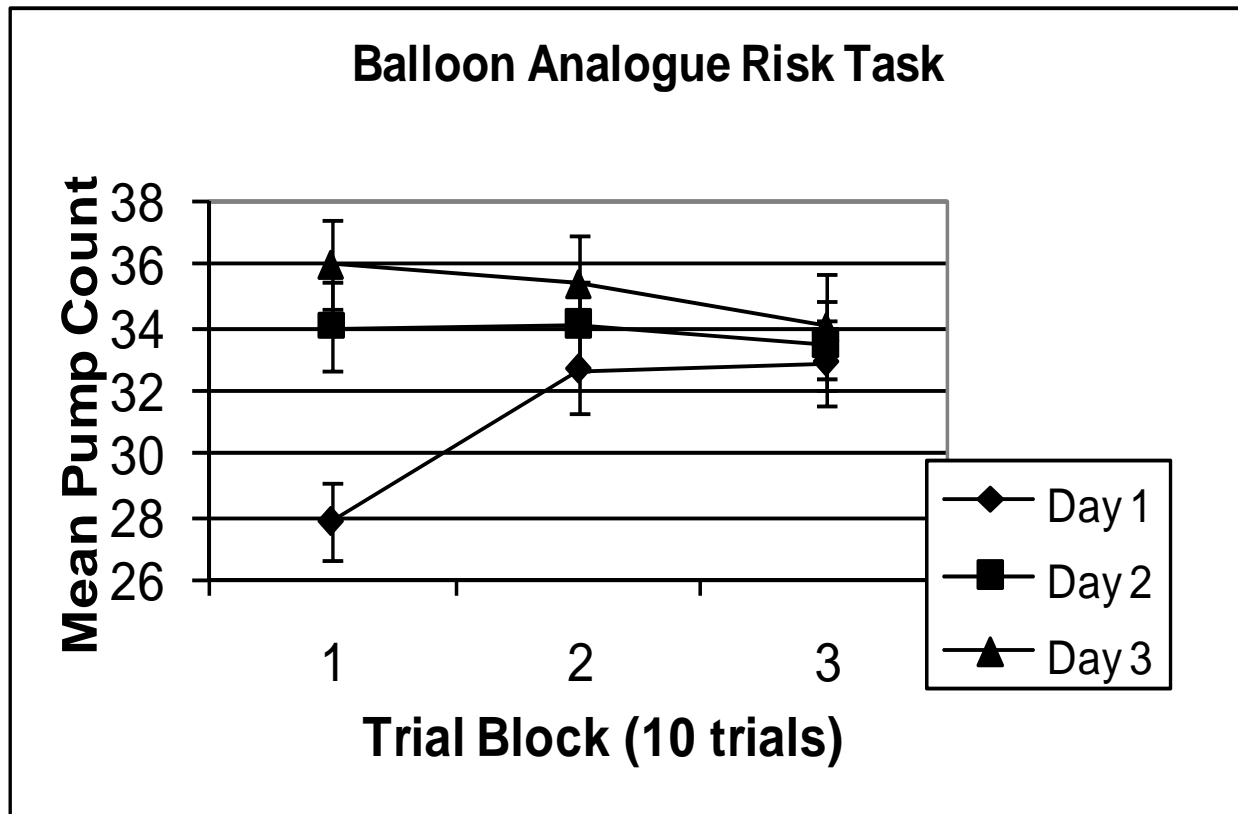


Figure 3. Balloon Analogue Risk Task performance by Block (10 trials) and Day (1, 2, or 3). Error bars are standard error of the means.

Brief Sensation Seeking Scale (BSSS)

For the BSSS, the total and four sub-scale (*boredom susceptibility*, *experience seeking*, *thrill and adventure seeking*, and *disinhibition*) scores were calculated. A repeated measures MANOVA was used to evaluate the effect of Day (1, 2, and 3) on the five scores which showed a non-significant effect, $F(2, 386) = 1.537, p = .216$. Nineteen participants were excluded from this analysis for incomplete data ($N = 194$).

Invincibility Scale

For the Invincibility Scale, mean change scores were calculated by taking the absolute value of subtracting one's score on Day 3 from that on Day 1. The analysis of mean change in scores showed that scores were relatively stable from Day 1 administration to Day 3 administration such that mean change scores were not significantly different from zero, $t(196) = -.449, p = .189$. Sixteen participants were excluded from this analysis for incomplete data ($N = 197$).

Correlational analysis

A correlational analysis was conducted to evaluate the relationships between performance on the subjective and objective measures included in the task battery. The results of this analysis showed that scores (from the first day of testing) on the EVAR ($r(181) = .184, p < .05$) and the BSSS ($r(181) = .213, p < .01$) significantly, positively correlated with performance on the BART. Invincibility scores significantly, positively correlated with scores on the EVAR ($r(173) = .34, p < .005$) and scores on the BSSS ($r(173) = .29, p < .005$). Performance on the MIGT did not correlate with performance on the other measures.

Discussion

The results of this study suggest the suitability of the assembled task battery for use in a longitudinal study of risk propensity in Soldiers across the deployment cycle. Participants' performance on the objective measures changed over administrations suggesting an effect of learning on performance. Specifically, performance on the MIGT showed that participants were sensitive to the reward/punishment contingencies and participants' performance on the BART became increasingly optimal (closer to optimal risk level to maximize payout) within a test administration as well as across the span of three days (three administrations). The continually improving performance on the tests across administrations suggests an effect of repeated exposure that may be eliminated by further altering the test versions. Responses on the subjective measures remained stable across the three-day span further supporting the reliability of these measures and, specifically, the suitability of these measures for a longitudinal study. Likewise, the relationships between the objective and subjective measures of sensation seeking and risk propensity suggest the use of the BART to supplement the self-report surveys. Also, this finding supports the validity of the EVAR as a subjective measure of risk propensity as it correlates with behavioral assessments (similar finding previously demonstrated by Killgore, 2007) which is largely atypical for self-report assessments of risk taking (Gianotti, et al., 2009).

Future studies

The basis of this study was to assess the suitability of the assembled task battery for future use. The long term project goals are to complete a longitudinal study of the effect of combat exposure on risk propensity and health risk behaviors across the deployment cycle. It is predicted that participants will exhibit greater risk propensity post-deployment compared to that pre-deployment such that their performance on the objective measures will indicate greater risk-taking behavior (e.g., high average number of pumps per trial and lower payout on the BART). It is also predicted that scores on the EVAR will increase to indicate greater risk propensity but personality measures such as the BSSS will remain stable across the deployment cycle. Given the results of this study, the assembled task battery will only be slightly modified for future use. Specifically, the MIGT will be altered such that the versions presented at each test administration will employ varied reward/punishment contingencies and the interface will more closely match that as described by Bechara, Damasio, Damasio, and Anderson (1994).

Conclusions

Results of this study suggest the suitability of the task battery for future use given that the results showed that: (1) participants performed at increasing optimal levels on the objective, behavioral measures across administrations; (2) remained stable on the subjective, self-report assessments across administrations; and (3) the subjective measures correlated with performance on at least one of the objective assessments. Given the results of this study, the task battery will be employed, with minor modifications, in the proposed longitudinal study.

References

- Bechara, A. 2001. Neurobiology of decision-making: risk and reward. Seminars in Clinical Neuropsychiatry. 6: 205-216.
- Bechara, A., Damasio, A. R., Damasio, H., and Anderson, S. W. 1994. Insensitivity to future consequences following damage to human prefrontal cortex. Cognition. 50: 7-15.
- Bechara, A., Damasio, H., Damasio, A. R., and Lee, G. P. 1999. Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. Journal of Neuroscience. 19: 5473-5481.
- Bechara, A., Damasio, H., Tranel, D., and Damasio, A. R. 1997. Deciding advantageously before knowing the advantageous strategy. Science. 275: 1293-1295.
- Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S. W., and Nathan, P. E. 2001. Decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. Neuropsychologia. 39: 376-389.
- Bechara, A., Tranel, D., and Damasio, H. 2000. Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. Brain. 123: 2189-2202.
- Bechara, A., Tranel, D., Damasio, H., and Damasio, A. R. 1996. Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. Cerebral Cortex. 6: 215-225.
- Bell, N. S., Amoroso, P. J., Wegman, D. H., and Senier, L. 2001. Proposed explanations for excess injury among veterans of the Persian Gulf War and a call for greater attention from policymakers and researchers. Injury Prevention. 7: 4-9.
- Gianotti, L. R. R., Knock, D., Faber, P. L., Lehman, D., Pascual-Marqui, R. D., Diezi, C., et al. 2009. Tonic activity level in the right prefrontal cortex predicts individuals' risk taking. Psychological Science. 20: 33-38.
- Hoge, C. W., Auchterlonie, J. L., and Milliken, C. S. 2006. Mental health problems, use of mental health services, and attrition from military service after returning from deployment to Iraq or Afghanistan. Journal of the American Medical Association. 295: 1023-1032.
- Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., and Koffman, R. L. 2004. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. New England Journal of Medicine. 351: 13-22.
- Hooper, T. I., DeBakey, S. F., Bellis, K. S., Kang, H. K., Cowan, D. N., Lincoln, A. E., et al. 2006. Understanding the effect of deployment on the risk of fatal motor vehicle crashes: A nested case-control study of fatalities in Gulf War era veterans, 1991-1995. Accident Analysis and Prevention. 38: 518-525.

- Killgore, W. D. S., Cotting, D. I., Thomas, J. L., Cox, A. L., McGurk, D., Vo, A. H., et al. 2008. Post-combat invincibility: Violent combat experiences are associated with increased risk-taking propensity following deployment. Journal of Psychiatric Research. 42: 1112-1121.
- Killgore, W. D. S., Kelley, A. M., and Balkin, T. 2009. Development and Validation of a Scale to Measure the Perception of Invincibility. Poster presented at the 29th Annual Anxiety Disorders Association of America (ADAA) conference. Albuquerque, NM.
- Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., et al. 2002. Evaluation of a behavioral measure of risk taking: The Balloon Analogue Risk Task (BART). Journal of Experimental Psychology: Applied. 8: 75-84.
- Magar, E. C. E., Phillips, L. H., and Hosie, J. A. 2008. Self-regulation and risk-taking. Personality and Individual Differences. 45: 153-159.
- Molina, M. E., Isoardi, R., Prado, M. N., and Beltolila, S. 2007. Basal cerebral glucose distribution in long-term post-traumatic stress disorder. World Journal of Biological Psychiatry. 13: 1-9.
- Prigerson, H. G., Maciejewski, P. K., and Roesnheck, R. A. 2002. Population attributable fractions of psychiatric disorders and behavioral outcomes associated with combat exposure among U.S. men. American Journal of Public Health. 92: 59-63.
- Rahman, S., Sahakina, B. J., Cardinal, R. N., Rogers, R. D., and Robbins, T. W. 2001. Decision making and neuropsychiatry. Trends in Cognitive Sciences. 5: 271-277.
- Stephenson, M. T., Hoyle, R. H., Palmgreen, P., and Slater, M. D. 2003. Brief measures of sensation seeking for screening and large-scale surveys. Drug and Alcohol Dependence. 72: 279-286.
- Tanielian T. and Jaycox L. H., eds. 2008. Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery. Santa Monica, CA: RAND Corporation.
- Zuckerman, M. 1994. Behavioral Expressions and Biosocial Bases of Sensation Seeking. Cambridge: Cambridge University Press.

Appendix A

Example of a Trial of the Modified Iowa Gambling Task

Instructions:

You will see four decks of cards on the screen; A, B, C, and D.

Select one card at a time from any deck you choose.

For each card, you will win some money.

For some cards, you will win and lose some money.

You are free to switch from one deck to the other at any time and as often as you wish.

The goal of the game is to win as much money as possible.

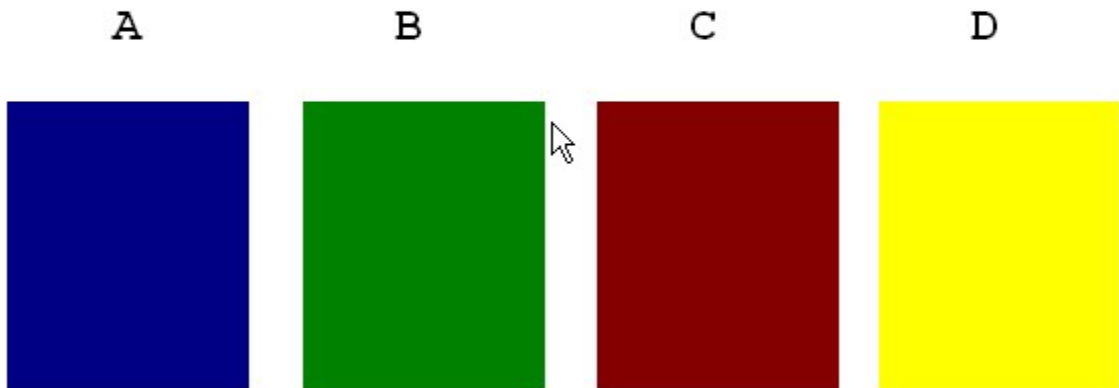
Some decks are worse than others.

No matter how much you think you are losing, you can still win if you stay away from the worst decks.

You will start with \$2000.

Press any key to continue.

Choose a deck!



Current total: \$2200
You won \$100!

A



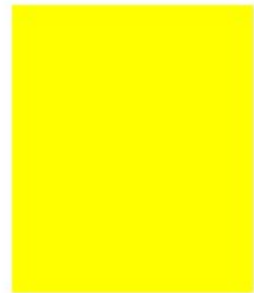
B



C



D



Current total: \$2050
You won \$100!

But lost \$150!

A



B



C



D



Appendix B

Evaluation of Risks Questionnaire

Instructions:

You will see a series of statements. For each statement, you will see a line representing a continuum between two extremes. Using the mouse, click the spot on the line that best represents YOU.

YOU DO NOT HAVE TO ANSWER ANY QUESTIONS THAT YOU DO NOT WANT TO ANSWER.

Press any key to continue.

Question 1 of 24

[Click here to skip question](#)

X

I feel like gambling



Not at all

Very much

Question 2 of 24

[Click here to skip question](#)

X

I am driving and the light turns yellow. I feel like



Stopping

Accelerating

Question 3 of 24

[Click here to skip question](#)

X

The light goes out in an unfamiliar stairwell



I do not move

I proceed immediately

Question 4 of 24

[Click here to skip question X](#)

I feel like



Avoiding everyone

Taking on the world

Question 5 of 24

[Click here to skip question X](#)

I feel like diving from a diving board that is



Very high

Very low

Question 6 of 24

[Click here to skip question X](#)

I like



Routine

Adventure

Question 7 of 24

[Click here to skip question X](#)

I seek



The thrill of danger

Tranquility

Question 8 of 24

[Click here to skip question](#)
X

I am in a hurry



I take a dangerous short cut

I take a safe detour

Question 9 of 24

[Click here to skip question](#)
X

I am open to



Negotiation

Confrontation

Question 10 of 24

[Click here to skip question](#)
X

I prefer to



Direct

Be supervised

Question 11 of 24

[Click here to skip question](#)
X

I give priority to



Reason

Action

Question 12 of 24

[Click here to skip question](#)

X

I like to listen to music



At loud volume

Very softly

Question 13 of 24

[Click here to skip question](#)

X

I am sure of myself



Not at all

Completely

Question 14 of 24

[Click here to skip question](#)

X

I prefer discussions which are



Animated

Calm

Question 15 of 24

[Click here to skip question](#)

X

A hostile situation



Weakens me

Reinforces me

Question 16 of 24

[Click here to skip question](#)

X

A menacing dog approaches



I confront it

Run away

Question 17 of 24

[Click here to skip question](#)

X

Faced with a potentially dangerous event



I take my time

I instantly react

Question 18 of 24

[Click here to skip question](#)

X

Seeing a person who is drowning, I first



Dive in

Call for help

Question 19 of 24

[Click here to skip question](#)

X

I prefer work that is



Well planned

Not planned

Question 20 of 24

[Click here to skip question](#)

X

I am right



All the time

Never

Question 21 of 24

[Click here to skip question](#)

X

I emphasize



Precision

Speed

Question 22 of 24

[Click here to skip question](#)

X

I like to drive



Very fast

Very slow

Question 23 of 24

[Click here to skip question](#)

X

I like to listen to music with a tempo that is



Very slow

Very fast

Question 24 of 24

[Click here to skip question](#)

X

I tend to take risks



Appendix C

Balloon Analogue Risk Task

Instructions:

Throughout this task, you will be presented with 30 balloons, one at a time.

For each balloon, you can press "p" to pump the balloon with air.

You will accumulate 5 cents in a temporary bank for each pump.

You will not be shown the amount you have accumulated in your temporary bank.

At any point, you can stop pumping the balloon and press "a" to collect the money in your temporary bank and add it to your permanent bank (Bank Total).

The amount you earned on the previous balloon is labeled "Last Balloon."

It is your choice to determine how much to pump up the balloon, but be aware that at some point the balloon will explode.

The explosion point varies across balloons, ranging from the first pump to over a hundred pumps.

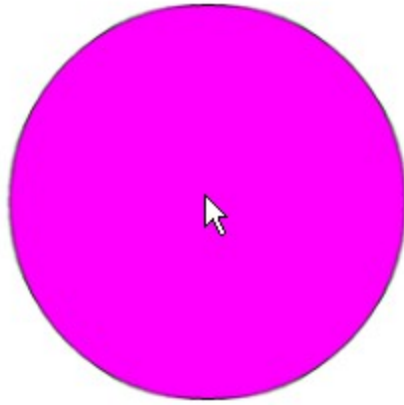
If the balloon explodes before you collect the money in the temporary bank, then you move on to the next balloon and all money in your temporary bank is lost.

Exploded balloons do not affect the money accumulated in your permanent bank.

Press any key to continue.

Press "A" to collect money
Press "P" to pump balloon

Last balloon: 0
Bank Total: 0

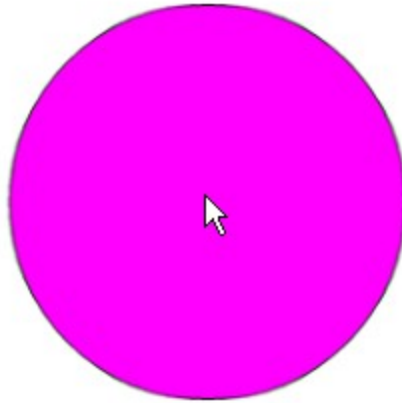


You earned: 25 cents
Total earned: 25 cents

Press any key to start the next balloon.

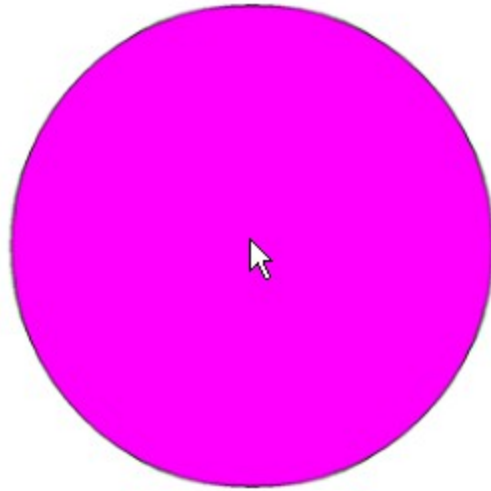
Press "A" to collect money
Press "P" to pump balloon

Last balloon: 25
Bank Total: 25



Press "A" to collect money
Press "P" to pump balloon

Last balloon: 25
Bank Total: 25

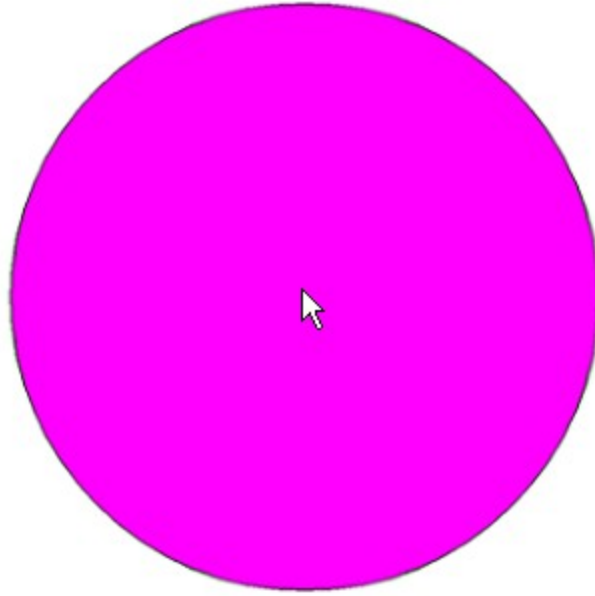


Popped



Press "A" to collect money
Press "P" to pump balloon

Last balloon: 30
Bank Total: 115



Appendix D

Brief Sensation Seeking Scale

Please read each item carefully. Using the key below, write in the number which bests how much you agree with the following statements **RIGHT NOW**.

YOU DO NOT HAVE TO ANSWER ANY QUESTIONS THAT YOU DO NOT WANT TO ANSWER. PRESS X TO SKIP A QUESTION.

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Disagree nor Agree
- 4 = Agree
- 5 = Strongly Agree

Right now I feel like...

Question 1 of 8.

I would like to explore strange places.

Question 2 of 8.

I get restless when I spend too much time at home.

Question 3 of 8.

I like to do frightening things.

Question 4 of 8.

I like wild parties.

Question 5 of 8.

I would like to take off on a trip with no pre-planned routes or timetables.

Question 6 of 8.

I prefer friends who are excitingly unpredictable.

Question 7 of 8.

I would like to try bungee jumping.

Question 8 of 8.

I would love to have new and exciting experiences, even if they are illegal.

Appendix E

Invincibility Scale

Read the following scenarios. Each scenario presents a situation and asks a question about the chance or likelihood that you would experience a particular outcome. For each one, think about how likely that outcome would be for YOU in that situation. Do NOT worry about how most people would do in a particular situation—just think about the chance that a particular outcome would happen to YOU in that situation.

Type in the percent chance that best represents the probability that the outcome would happen to YOU.

Press any key to continue.

Read the following 50 scenarios. Each scenario presents a situation and asks a question about the chance or likelihood that you would experience a particular outcome. For each one, think about how likely that outcome would be for YOU in that situation. Do NOT worry about how most people would do in a particular situation—just think about the chance that a particular outcome would happen to YOU in that situation. Circle the percent chance that best represents the probability that the outcome would happen to YOU.

YOU DO NOT HAVE TO ANSWER ANY QUESTIONS THAT YOU DO NOT WANT TO ANSWER. PRESS X TO SKIP A QUESTION.

1. A traffic light turns red as you approach the intersection, but you decide to run it anyway. What is the chance that YOU will make it through safely?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. You arrive at the airport 5 minutes before your flight is scheduled to depart. If you rush to the gate, what is the chance YOU will make your flight?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. Your friend drives up on a motorcycle and convinces you to hop on and go for a ride. Unfortunately, there was not an extra helmet, so you ride without one. Trying to impress you, your friend starts speeding and makes several risky turns at high velocity. The motorcycle goes out of control and crashes, with you thrown many feet across the pavement. What is the probability that YOU will suffer a permanent brain injury that will cripple you for life?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. You arrive 25 minutes late for a big job interview. What is the probability that YOU will get the job?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. You have spent the past 9 hours on an overseas flight sitting in the middle seat between two passengers, both of whom are coughing and sneezing frequently due to having contracted very bad colds. What is the chance that YOU too will come down with a cold after the flight?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. You are driving 50 mph on a dark and winding mountain road in the middle of winter. As you turn a curve, your car hits a patch of ice and swerves uncontrollably. What is the chance that YOU will be able to regain control of the car and not crash?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. While driving a rented sedan through an unfamiliar marshy region, you find that the dirt road you are on is blocked by a small but potentially sticky mud patch. If you try to drive onward through the mud, what is the chance that YOU will get stuck?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If you were to invest \$1000 in the stock market, what is the chance that YOU would make a profit?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. While you are flying on a commercial airplane, a lone hijacker stands up next to you holding a box and screaming that he will blow up the plane if anyone attempts to overpower him. What is the likelihood that YOU will die in this incident?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If you were to find yourself confronted by a vicious angry dog, what is the probability that YOU could get away unharmed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. If you were to walk a quarter mile down a dark alley in a rough neighborhood of an unfamiliar city, what is the chance that YOU would be harmed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

12. You are driving down a dark and isolated highway and have stopped to give a ride to a hitchhiker. Upon opening the door, you see that he is very menacing looking and wearing clothing with symbols from a group that is known to have been hostile to your ethnic group in the past. What is the chance that YOU will be harmed by this person if you give him a ride?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

13. You are running late for an important meeting about 20 miles away and decide to drive fast to get there on time. As you drive down the freeway you realize that you are driving 79 MPH in a 55 MPH zone. What is the chance that YOU will get a speeding ticket if you continue at your current speed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

14. Regardless of your moral convictions, if you were to shoplift a pair of \$50 sunglasses from a chain drug store, what is the probability that YOU could get away with it without being caught?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

15. Regardless of your moral convictions, if you were to choose to have a secret affair outside of your primary relationship/marriage, what is the likelihood that YOU could do it without ever being caught by your partner/spouse?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

16. Your boss has confronted you about a discrepancy on your timesheet and has threatened to fire you. Against your better judgment, you tell a small lie to keep your job. What is the chance that YOUR lie will be discovered?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

17. Regardless of your moral convictions, if you were to under-report your income to the IRS by 5%, what is the probability that YOU could get away with it?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

18. While standing in line at the bank, an armed robber brandishing a gun takes you as the lone hostage as part of a bank robbery. If you, acting alone, attempted to overpower the robber when he wasn't looking, what is the chance that YOU would be killed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

19. While on a business trip to Las Vegas, you decide to go down to the casinos and play for a while to pass the time. Before you know it, you have been playing for 6 hours. What is the probability that YOU will return to your hotel room with more money that you left with?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

20. You and your buddy get into a friendly debate over some trivia. You eventually realize that your buddy is actually right and you are wrong, but you decide to stick to your original argument anyway out of stubbornness. When all is said and done, how likely is it that YOU will have won the argument?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

21. While leaving a popular night club, you are attacked by a drunk man in his early 20s wielding a 10 inch knife. During the scuffle, your friend is stabbed, but not fatally. What is the chance that YOU will be killed during the attack?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

22. You are riding the escalator in a crowded shopping mall when a man on the second floor about 40 feet away from you pulls out a pistol and starts shooting at the people on the escalator. What is the probability that YOU will survive this incident unharmed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

23. You have been eating your usual diet for years. What is the chance that YOU will avoid heart related problems and survive past age 70?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

24. While on vacation, you meet up with a stranger asking for help. Although the story the stranger tells you is heart wrenching and he seems very sincere, you are aware that he may just be a con-artist trying to scam you. If the stranger truly is a con-artist, what is the probability YOU will end up being scammed out of some of your money?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

25. You awaken one morning realizing that you engaged in unprotected sex with someone you just met. Now that the alcohol has worn off, your partner remorsefully tells you that he/she has suffered for a long time with a very serious sexually transmitted disease. What is the chance that YOU will contract the sexually transmitted disease yourself after this contact?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

26. While jogging you begin to feel tightness in your chest and become lightheaded. Several people see you as you fall to the ground unconscious and they call for help on a cell phone. What are the odds that YOU will survive this incident and return to your previous level of functioning?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

27. While on vacation in a far away country, your 3 traveling companions have all contracted a bad case of diarrhea after drinking the water. You realize that you just drank some of the same water about an hour ago. What is the likelihood that YOU will come down with diarrhea too?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

28. Just as you drive up to a railroad crossing, the warning gates drop to let you know a train is approaching. The crossing is somewhat washed out and muddy, and the train is approaching at 70 MPH, but is still about a quarter mile away. If you rush through the gates quickly, what is the chance that YOU will make it across safely?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

29. You are taking an important entrance examination that could significantly improve your life situation if you pass. You are uncertain about your answers to the last three questions, but can easily see the answers provided by the two people seated closest to you. If you cheat on this test, what is the probability that YOU will get caught?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

30. While on vacation in the woods, you decide to go hiking in an unfamiliar and thickly wooded area without a map or guide. What is the likelihood that YOU will get lost?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

31. You have been at a nightclub for 4 hours. During that time you have had 7 alcoholic beverages. You are feeling a little “buzzed” but you decide to drive yourself home anyway because it is only about 5 miles away. What is the probability that YOU will make it home without any negative incident?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

32. While playing golf one afternoon a thunderstorm comes up quickly. There is much wind and occasional lightning is hitting nearby. Because you are winning the game and only have two more holes to play, you decide to continue to the end. What is the likelihood that YOU will be struck by lightning before finishing the game?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

33. You are driving down a crowded highway during the winter holiday season. A thick and blinding blizzard has come up and it is almost impossible to see the next car in front of you. If you continue driving at your current speed of 35 MPH, what is the likelihood that YOU will have an automobile accident before your trip is through?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

34. While enjoying the winter snow with some friends, you notice that a puppy has just fallen through a hole in the ice on the frozen pond. It is well below freezing outside and the ice looks solid enough to walk on in most places. What are the odds that YOU could successfully rescue the puppy without falling through the ice yourself?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

35. While at your job you discover that one of your superiors has been embezzling large amounts of money from your organization. You decide to inform higher management of his illegal behavior. What is the chance that YOUR future career at the company will be harmed by reporting him?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

36. Your company has a strict policy forbidding the removal of computer equipment from the work premises. However, you have a big project due that can only be completed if you “borrow” a company laptop computer over the weekend. What is the probability that YOU could secretly remove the computer for the weekend and return it to work on Monday without ever being caught?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

37. You are a foreigner living in a war-torn country that is filled with violence and frequent sniper attacks. Although it is dark outside and there are many hostile insurgents in the area, you decide to drive alone and unarmed down a 10 mile stretch of empty highway to spend the weekend in the next town. What is the probability that YOU will be killed while making the trip?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

38. While at a party with several friends, you are challenged to play a new game of skill that you have never played before. The game seems to rely on several skills that you know are some of your best strengths. What is the probability that YOU will end up as the winner of the game?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

39. While staying at a high rise hotel a bad fire breaks out several floors below yours. After hearing the fire alarm and smelling smoke, you quickly devise a plan of escape. What is the likelihood that YOU would be unable to figure out a way to escape and would die in the fire?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

40. A severe natural disaster has devastated your town, resulting in widespread panic, looting, and deadly violence. The escape routes leading from the town are blocked with gridlock traffic and street gangs are killing at random and using violent means to steal limited necessities and survive. What is the chance that YOU will be able to outmaneuver the looters and escape the town unharmed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

41. You enter a competition in an arena in which you are particularly talented. What is the chance that YOU will ultimately win the competition?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

42. You are sightseeing off a tall bridge where many individuals have tried to commit suicide by jumping to their deaths in the water below. Approximately half of all jumpers have not survived the long drop into the bay. Unfortunately, you stumble and are accidentally knocked off of the bridge. What is the likelihood that YOU would die in the fall?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

43. A friend of yours was cleaning his pistol, a revolver that holds 6 bullets. As a joke, he loaded several bullets and spun the cartridge and pointed it at your face with the hammer cocked. While he was doing this, he unexpectedly sneezed and the hammer snapped down forcefully. What is the probability that YOU would be killed by this incident?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

44. Your biggest rival has challenged you in some way. What is the likelihood that YOU will ultimately defeat your rival at whatever he/she has challenged you with?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

45. While hiking in the wilderness you find yourself lost and alone with only the clothes on your back. As evening approaches, you can tell it is getting colder and you know you are miles from help. What is the chance that YOU will survive this experience and return to your normal life?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

46. A bad automobile accident has just occurred in front of you. In one of the cars, the driver is unconscious and bleeding. You smell gas and notice that smoke is starting to billow out from the car. Afraid that the car may explode at any moment, you work to pull the unconscious driver from the car. What is the chance that YOU will die in the process of saving the driver?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

47. It is after dark as you walk to your car in a dimly lit parking lot. You notice a group of several tough looking young men walking down the street as they change their course to walk straight toward you. They try to start trouble by calling you bad names so you hurl an insult back at them and walk faster to your car. What is the chance that YOU will leave this situation unharmed?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

48. While on vacation on a tropical island you decided to rent a small motor boat to do some sightseeing and fishing out along the island coast. After stopping the boat some distance from the shore you lay down to take a brief nap. Upon awakening you realize that you can no longer see the shore and notice that there is a fierce storm coming. What is the likelihood that YOU will die at sea?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

49. While at the hospital visiting a sick friend, you finish your soda and throw it into what appears to be a waste bucket, but your ring slips off your finger and falls into the waste bucket too. When you reach into the bucket you are accidentally stuck by a syringe needle that was used to draw blood from another patient. What is the likelihood that YOU will become infected?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

50. Due to an apparent misunderstanding, you have been charged with sexual harassment by a fellow coworker. What is the likelihood that YOU will ultimately prove your accuser wrong and win the case?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



DEPARTMENT OF THE ARMY
**U.S. Army Aeromedical
Research Laboratory**
Fort Rucker, Alabama 36362-0577